MARKETING
RESEARCH
REPORT
952

RETAIL DEMAND FOR FRESH APPLES

U.S. DEPARTMENT OF AGRICULTURE
ECONOMIC RESEARCH SERVICE

ABSTRACT

Seasonal retail demand for fresh apples was estimated for 1963/64-1969/70 with linear regressions of U.S. average monthly retail prices on monthly net per capita fresh movement. After remaining essentially unchanged from 1963/64 through 1965/66, demand increased during 1966/67-1968/69. By 1968/69, a given level of per capita consumption was maintained at a price about 3 cents a pound higher (deflated) than in 1963/64. The apparent, sharp decrease in demand that followed in 1969/70 probably reflected lower quality more than a real change in demand. Intraseasonal demand was presented in terms of price flexibilities calculated at four levels of net movement. These levels represented average net movement in each of four 3-month time periods. Flexibilities trended downward during the seven seasons studied. By 1968/69, they ranged from -0.3727 in September-November to -0.0431 in June-August. Total retail revenue would have been increased by additional movement in all time periods and also by reallocating supplies from fall and winter to spring and summer.

Keywords: Apples, demand, price flexibility.

PREFACE

This publication reports on part of a larger research effort concerning a number of aspects of the U.S. apple industry. As one aspect, the Marketing Economics Division, Economic Research Service, U.S. Department of Agriculture (USDA), is developing an interregional activity analysis model of the industry, and some of the demand relationships that were developed as inputs to this model are presented here. Other model requirements include data on packing and processing costs which have been collected and will be published separately. In addition, personnel in colleges in major apple-producing areas are cooperating, formally and informally, in related research.

Washington, D.C. 20250

April 1972

CONTENTS

FIGURES

TABLES

APPENDIX TABLES

SUMMARY

Retail demand for fresh apples rose during 1966/67-1968/69, after remaining essentially unchanged from 1963/64 to 1965/66. By 1968/69, consumers maintained a given level of per capita consumption at a price level 3 cents a pound higher (deflated) than in 1963/64--the beginning of the period studied. Demand appeared to drop sharply in the final season examined--1969/70--but this shift was probably due to a lower quality crop instead of a real decline in demand. In six of the seven seasons studied, per capita net movement explained more than 91 percent of the variation in retail price. In the seventh season, such movement accounted for 80 percent of the variation.

The relatively small shifts in demand from 1963/64 to 1965/66 had limited impact on total revenue from sales of fresh apples. However, the rapid increase in demand during the next three seasons contributed substantially to the higher total revenue--about $25 million in 1966/67, $48 million in 1967/68, and $33 million in 1968/69. The apparent decline in demand during 1969/70 had a negative effect on total revenue of nearly $85 million, but this loss was more than offset by gains due to other factors, particularly increased fresh apple movement and inflation. Again, the loss probably reflected the lower quality of the crop, not a change in the demand relationship.

Population growth, another contributor to higher total revenue, accounted for $5-6 million of total revenue each season. Inflation had considerably more significance, contributing $48 million in 1968/69 and 1969/70. This amount more than canceled out the entire gain in real revenue of 1969/70. Season-to-season changes in fresh apple movement had relatively large effects on total revenue, ranging from a $38-million loss in 1965/66 to one of $66 million in 1969/70.

Total revenue would have been increased by larger movements of fresh apples in all seasons of the year and by reallocation of a given seasonal supply from fall and winter to spring and summer. Price flexibilities, used to show intra-seasonal demand, represented the percentage change in price that accompanied a 1-percent change in net movement. In each season and time period, price flexibilities were negative and less than one; a 1-percent change in per capita net movement was associated with a less than 1-percent change in price in the opposite direction. Largest price responses occurred during September-November, the period of greatest average movement.

Omission of prices for Delicious apples from the Bureau of Labor Statistics retail pricing sample represented the most serious limitation in data. If Delicious varieties had been included, the U.S. average deflated seasonal prices would have been 1.2 to 1.7 cents a pound higher and price flexibilities would have been reduced 7 to 10 percent.

have been available for a demand analysis involving time series. Consequently, to include enough observations for statistical validity, a long time period has had to be used--generally 15 years or more. As a result, the assumption that the demand shifters remain unchanged becomes unacceptable. Researchers have adjusted by including these variables in their analysis to the extent possible. The resulting demand relationships are well suited for predicting but less satisfactory for determining shortrun shifts in slopes and elevations or for estimating price flexibilities.

Time series data were used in this report but the analysis was based on a relatively short period; a separate regression was run for each season. Seven seasons were analyzed--1963/64-1969/70. The seasonal approach was made possible by the availability of high-quality monthly price and movement data. But having only 12 observations per season limited the number of independent variables and only one was used--net monthly movement of fresh apples. For this simplified specification of the demand equation to approximate true demand, the assumption "other things equal" must be reasonably met. The effect of population growth was eliminated by converting movement data to a per capita basis. Changes in monetary value were controlled by deflating monthly fresh apple prices with monthly Consumer Price Indexes (CPI). For other demand shifters, it was necessary to assume that their impact during the relatively short time of one season was small. Previous research supports this assumption to the extent that changes in consumer income and in prices of substitutes were generally found to have limited impact on demand for fresh apples.

If these techniques are effective and the assumptions correct, changes in the single independent variable--net monthly movement--should explain a major portion of changes in fresh apple prices.

Seasons were arbitrarily set to extend from September through August, beginning with the heavy fall harvest when apples go into storage and continuing through the marketing period which is essentially completed by the end of August. In June, July, and August, fresh apples from the new crop are on the market. Generally, the volume of new apples exceeds that of stored apples only in August.

Parts of the analysis were based on periods rather than months. Within a season, the volume of monthly movement varies greatly--from less than 60 million pounds to around 500 million pounds. Over such wide variations, price flexibilities along a linear demand curve also vary considerably, with important intraseasonal implications. These are doubly significant for fresh apples because not only are the variations over the season large, but also closely and consistently related to time. Therefore, the season was divided into four 3-month time periods. These periods fell into a consistent relationship with regard to their position on the demand curve (fig. 1). Consequently, price flexibilities at points on the demand curve could be related both to a quantity flow and a time period. The months included in each period are as follows:

Period I--September, October, November
Period II--December, January, February
h, April, May
July, August

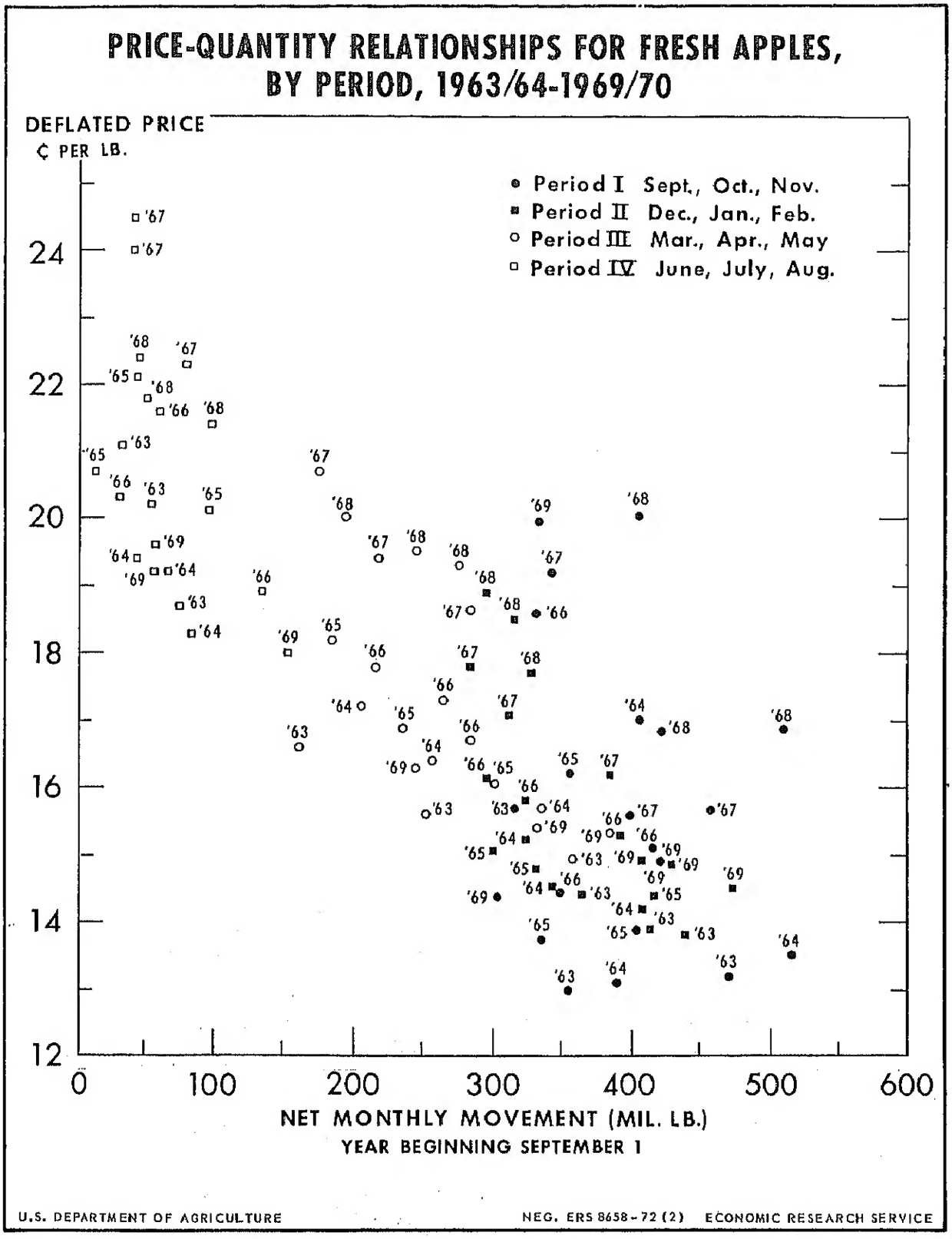
PRICE-QUANTITY RELATIONSHIPS FOR FRESH APPLES, BY PERIOD, 1963/64-1969/70
DEFLATED PRICE
¢ PER LB.
Period I Sept., Oct., Nov.
Period II Dec., Jan., Feb.
Period III Mar., Apr., May
Period IV June, July, Aug.
24
22
20
18
16
14
12
0
100
200
300
400
500
600
NET MONTHLY MOVEMENT (MIL. LB.)
YEAR BEGINNING SEPTEMBER 1
U.S. DEPARTMENT OF AGRICULTURE
NEG. ERS 8658-72 (2) ECONOMIC RESEARCH SERVICE

Figure 1

A single-equation least-squares method was chosen for the analysis. To justify its use when the objectives involved estimating structural coefficients, it had to be shown that supplies moving into market channels, consumers' income, and supplies of competing commodities were not significantly affected by current retail prices. The latter two conditions are generally easily accepted but the first is not.

Total apple production in any given season depends on the number and yield of bearing trees. These variables are not influenced by apple prices for that season. That is, total production for a particular season is predetermined.

It is less clear how total production is allocated between fresh and processing outlets. But the contention here is that much rigidity exists in the allocation procedure and that current prices have limited influence. The validity of this statement varies considerably among producing regions. But many factors serve to "lock in" current production to one outlet or the other--variety of apple, cultural practices, forms of contracts, availability of market outlets, availability of storage facilities, and condition of the crop. These, and other factors, may override the effect of current prices in the allocation of much of the crop.

Factors other than current prices may also primarily determine the seasonal marketing pattern for the stored portion of the crop. Condition of the crop, need to maintain a work force, advantage of regularity in supplying market outlets, past experience, and other variables strongly influence the flow to market. Consequently, marketing patterns tend to be very similar from season to season (table 1). Differences that do occur can usually be attributed mainly to factors such as condition of the crop, time of harvest, weather, and so on.

The extent of joint determination in the allocation procedure would thus seem to be limited and the least-squares single-equation method should provide a reasonably accurate estimate of the desired structural coefficients.

SOURCES AND TYPES OF DATA

Monthly price and quantity data were used for September 1963 through August 1970. Retail prices are those collected and published by the Bureau of Labor Statistics, (BLS), U.S. Department of Labor, for all-purpose apples, U.S. No. 1 or U.S. Fancy, medium-sized. (BLS excludes cooking apples and all varieties of Delicious apples). Data are collected in 39 Standard Metropolitan Statistical Areas and 17 smaller cities selected to represent all urban areas of the United States. Prices are recorded monthly on Tuesday, Wednesday, or Thursday of a specified week preceding the 15th day of the month. In each city, BLS agents gather data in chains, other large stores, and small stores and weight these statistics by volume of sales by each store. The resulting average city prices are weighted by population to obtain U.S. average prices.

Figures for net monthly movement per capita were calculated from Interna-
Association reports; and from USDA's Consumer and Marketing Service
Foreign Agricultural Service import and export data, and Statisti-
orage reports. September statistics had to be ad-
representative of the time of month during which

Table 1.--Net monthly movements of fresh apples as a percentage of total seasonal movement, 1963/64-1969/70

Month	Net monthly movement as a proportion of total seasonal net movement							
	1963/64	1964/65	1965/66	1966/67	1967/68	1968/69	1969/70	Average
	Percent							
September	9.6	12.0	11.8	10.7	11.4	12.7	9.3	11.1
October	14.3	15.3	13.3	13.4	15.2	16.0	11.7	14.2
November	10.8	11.5	11.2	11.3	13.2	13.2	8.4	11.4
December	13.3	12.0	13.8	12.6	12.7	10.3	13.2	12.6
January	12.4	10.2	11.0	10.4	10.3	9.9	11.9	10.5
February	11.1	9.6	9.9	9.6	9.4	9.3	11.3	10.1
March	10.9	10.0	10.1	9.2	9.4	8.7	10.7	9.9
April	7.6	7.5	7.8	8.6	7.2	7.7	9.2	8.0
May	4.9	6.1	6.1	6.9	5.8	6.0	6.8	6.1
June	2.3	2.5	3.2	4.3	2.6	3.1	4.2	3.2
July	1.1	1.3	.4	1.0	1.4	1.5	1.6	1.2
August	1.7	2.0	1.4	2.0	1.4	1.6	1.7	1.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

prices were collected; that is, Tuesday, Wednesday, and Thursday of usually the first full week. The situation arose because the apple harvest accelerates rapidly during September and movement to fresh markets also quickly increases. To illustrate, the average volume for August during the seven seasons studied was 54.1 million pounds. The average September volume was 358.0 million pounds, and for October, 457.7 million. Thus, the rate of movement during the first week in September (when prices are collected) was always considerably below the average for the month. Since nothing could be done about the time of pricing, fresh movement for September was adjusted as though the rate of the first week prevailed throughout the month. (Calculation procedures are explained in the appendix.)

SEASONAL DEMAND FOR FRESH APPLES

Initially, for each of the seven seasons included, a least-squares regression was run with deflated U.S. average monthly retail prices on net per capita monthly apple movements to the U.S. fresh market (table 2). For all seasons, net monthly movements to the fresh market explained a large portion of the variation in monthly retail prices. For the first six seasons, the relationship was particularly close; the coefficients of determination, (R^2), ranged from 0.910 in 1963/64 to 0.957 in 1967/68. In the final season 1969/70, the relationship was not as close; the coefficient of determination dropped to 0.805. The relatively poor fit is probably related to the low quality of part of the 1969/70 crop.

The seven equations are shown graphically in figure 2. Each regression was extended over the actual range of net per capita monthly movement for that season. The seven linear regressions differed both in slopes and elevations. Slopes ranged from a change of 2.486 cents in price for each 1-pound change in net per capita monthly movement in 1968/69 to 4.270 cents in 1967/68. The range

Table 2.--Estimated demand relationships for fresh apples, 1963/64-1969/70

Season	Constant term	Regression coefficient	"t" value	Standard error of estimate	Coefficient of determination
1963/64	0.20466	-0.03161	10.05	0.00856	0.910
1964/65	.19853	-.02679	11.71	.00585	.932
1965/66	.21677	-.03912	10.76	.00831	.921
1966/67	.21549	-.03330	10.59	.00657	.918
1967/68	.24424	-.04270	14.90	.00669	.957
'	.22570	-.02486	13.64	.00425	.949
	3	-.02637	6.43	.00989	.805

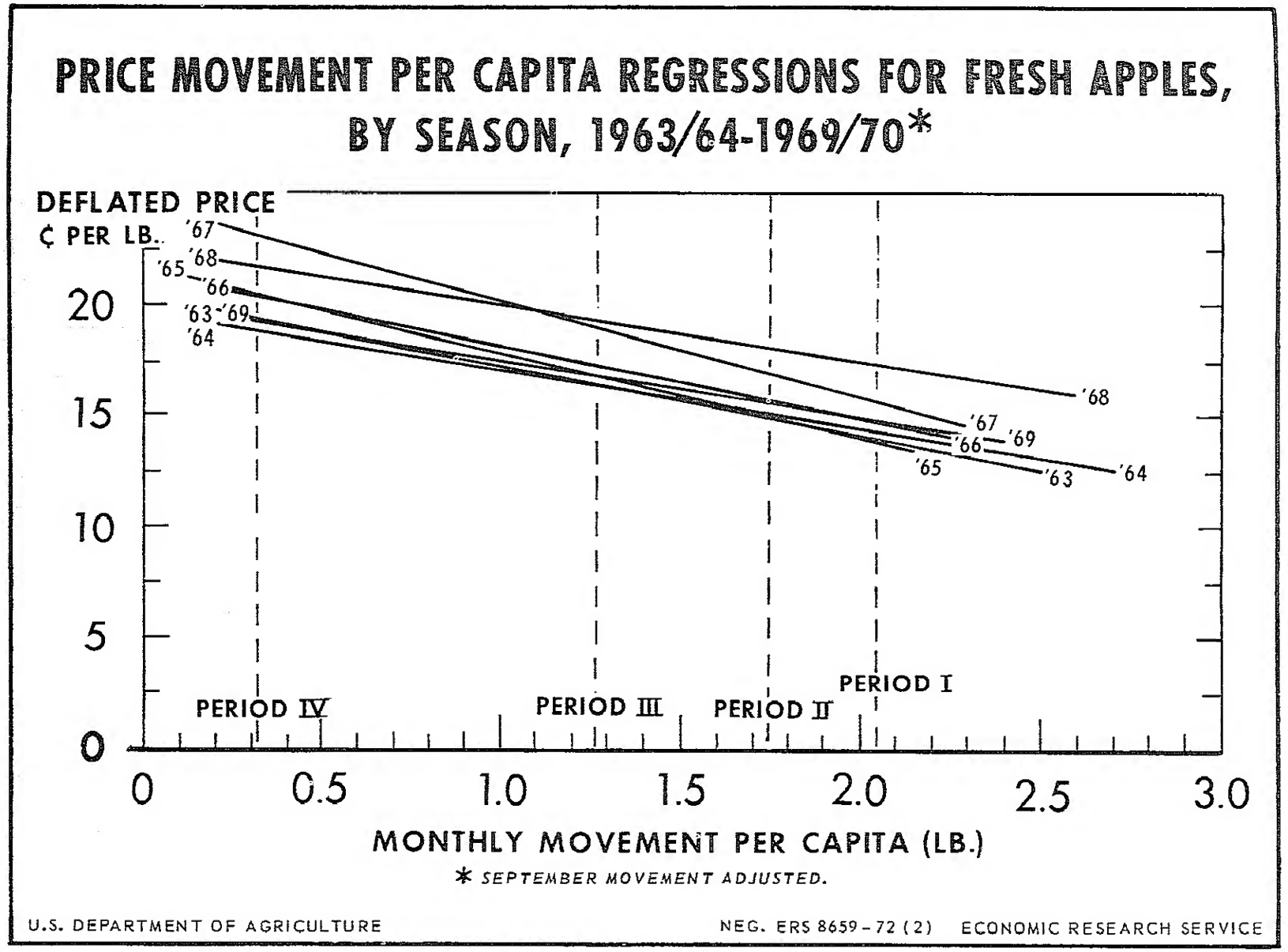
PRICE MOVEMENT PER CAPITA REGRESSIONS FOR FRESH APPLES, BY SEASON, 1963/64-1969/70*
DEFLATED PRICE
¢ PER LB.
20
15
10
5
0
'67
'68
'65
'66
'63
'69
'64
PERIOD IV
PERIOD III
PERIOD II
PERIOD I
0
0.5
1.0
1.5
2.0
2.5
3.0
MONTHLY MOVEMENT PER CAPITA (LB.)
* SEPTEMBER MOVEMENT ADJUSTED.
U.S. DEPARTMENT OF AGRICULTURE
NEG. ERS 8659-72 (2) ECONOMIC RESEARCH SERVICE

Figure 2

in elevations of the seven regressions at a given per capita movement generally was close to 4 cents. Another possible difference, not visible in figure 2, is among the variances. Unless the hypothesis of equal variances holds (cannot be rejected), little can be said concerning slopes and elevations. Separate tests were made for homogeneity of variances, slopes, and elevations of the regressions.

In a test for homogeneity of variances, the mean square of deviations from the regression for each season after 1963/64 was compared with the mean square for 1963/64 to see if they were statistically equal. This hypothesis could not be rejected, except for 1968/69 at the 5-percent level but not at the 1-percent level (table 3). In other words, the assumption of a common variance among the seven seasons could reasonably be accepted. Thus, slopes and, more importantly, elevations could be compared.

For the analysis of slopes, each successive regression coefficient, or "b" value, was compared with that of the base season--1963/64. Specifically, the hypothesis being tested was:

$$\text{Ho:} \quad b_{1963/64} = b_{1964/65}$$

$$\vdots$$

$$b_{1963/64} = b_{1969/70}$$

$$F = \frac{\text{mean square for regression coefficients}}{\text{mean square within samples}}$$

Table 3.--Test for homogeneity of variance for fresh apples, 1963/64-1969/70

Season	Mean squares of deviations from regression	Ho:	F value 1/	Conclusion
1963/64	0.000073243			
1964/65	.000034195	$s^2_{1963/64} = s^2_{1964/65}$	2.14	Cannot reject
1965/66	.000069138	do. = $s^2_{1965/66}$	1.06	Cannot reject
1966/67	.000043112	do. = $s^2_{1966/67}$	1.70	Cannot reject
1967/68	.000044789	do. = $s^2_{1967/68}$	1.64	Cannot reject
1968/69	.000018074	do. = $s^2_{1968/69}$	4.05*	Reject at .05
..	.000097866	do. = $s^2_{1969/70}$	1.33	Cannot reject

), 9; 0.05 = 3.18 and 0.01 = 5.35.

The hypothesis that each "b" value was equal to that of 1963/64 could not be rejected, except for 1967/68, at the 5-percent level but not at the 1-percent level (table 4). The "b" value for 1967/68 was considerably larger than in other seasons. The regression had a steeper slope: 4.270-cents change in price for each 1-pound change in per capita movement, compared with 3.161 cents in 1963/64. The F-test indicated the difference was greater than could be expected from that due to sample variation. The relatively minimal 1967/68 crop partly explains the larger difference--total per capita movement was 15.250 pounds, smallest of the seasons studied. With such a crop, a given change in per capita movement apparently has a greater impact on price. The next smallest per capita movement was in 1965/66 and the regression for that season had the next steepest slope. However, this slope did not prove to be statistically different from that of 1963/64. Therefore, except for 1967/68, the slopes of the various regressions did not differ statistically from that of the base season--1963/64.

The preceding tests justified reasonably well the assumptions of homogeneous variance and similar slopes among the seven regressions. Thus, the more relevant question of differences in elevation could be considered. In other words, changes in the level of demand over the seven seasons could be examined. Specifically, this test answers the question: if net per capita movements were the same each season, would prices have been the same? Again, each regression was compared with the base year--1963/64.

Table 4.--Comparison of slopes of seasonal price movement regressions for fresh apples, 1963/64-1969/70

Season	Regression coefficient	Ho:	F value 1/	Conclusion
1963/64	-0.031613			
1964/65	-.026794	$b_{1963/64} = b_{1964/65}$	1.52	Cannot reject
1965/66	-.033301	do. = $b_{1965/66}$	2.44	Cannot reject
1966/67	-.039121	do. = $b_{1966/67}$	1.45	Cannot reject
1967/68	-.042705	do. = $b_{1967/68}$	6.57*	Reject at .05
1968/69	-.024860	do. = $b_{1968/69}$	3.13	Cannot reject
1969/70	-.026371	do. = $b_{1969/70}$	1.05	Cannot reject

1/ $F = \frac{\text{mean square for regression coefficient}}{\text{mean square pooled}}$; $F_{20}^{1} = 0.05 = 4.35$ and $.01 = 8.10$.

* Significant at the .05 level.

The hypothesis that deflated prices would have been the same as in 1963/64 if per capita quantities had been the same could not be rejected for 1964/65 and 1965/66 (table 5). The level of the regressions in these three seasons was not statistically different. Subsequently, demand apparently began increasing and the hypothesis was rejected for 1966/67, 1967/68, and 1968/69. The differences were progressively greater, indicating an upward-shifting demand curve. The trend sharply reversed in 1969/70, when the regression shifted back to about the 1963/64 level. However, for several reasons, 1969/70 data were not comparable with the other seasons. Most important was the generally low quality of the Washington crop, caused by a severe freeze the preceding winter. Much of this crop did not come out of storage in the condition expected by the trade and by consumers.

A further complication was that Delicious varieties, which make up most of the Washington crop, were not in the BLS pricing sample. On the other hand, most of the varieties in the sample were of satisfactory quality in 1969/70. The important question then, was how the quality of the Washington crop affected prices for other apples. Some industry leaders believed there was a depressing effect on all apple prices. This situation could have resulted if people who bought low-quality Washington apples did not associate them with that area but rather with apples in general. If so, the prices received for the 1969/70 U.S crop would have been lower than in the three previous seasons even if per capita movements had been the same. Thus, the situation in 1969/70 probably did not represent a true decline in demand. Instead, the seasonal regression represents

Table 5.--Comparison of elevations of seasonal price movement regressions for fresh apples, 1963/64-1969/70

Season	Unadjusted means: Price	Unadjusted means: Quantity	Ho: Would price be the same if quantity were the same? (F value 1/)	Conclusion
1963/64	15.92	1.4363		
1964/65	16.14	1.3850	0.03	Cannot reject
1965/66	17.33	1.2658	.37	Cannot reject
1966/67	16.86	1.2317	7.80*	Reject
1967/68	19.26	1.2097	49.43**	Reject
1968/69	19.42	1.2651	106.36**	Reject
1969/70	16.42	1.4214	1.45	Cannot reject

1/ $F = \frac{\text{mean square, adjusted means}}{\text{1 square common}}$; $F_{21}^{1} = 0.05 = 4.32$ and $0.01 = 8.02$.

demand for a different (lower quality) product not directly comparable with the other seasons. The fact that both size of the crop and seasonal per capita movement in 1969/70 were largest of the seven seasons studied probably had little to do with the shift in regression. Another year's data for apples of normal quality would be needed for a complete evaluation.

INTRASEASONAL DEMAND FOR FRESH APPLES

In this report, as mentioned, demand is represented by seasonal linear regressions of monthly prices on monthly net movements. Shifts in the line within a given season were not permitted. Therefore, intraseasonal demand is presented as the difference along a given regression in relative changes in price and quantity. To be specific, the analysis is in terms of price flexibility, defined as the percentage change in price that accompanies a 1-percent change in quantity. For example, a price flexibility of -0.3000 indicates that a 1-percent change in quantity was associated with a 0.3-percent change in price in the opposite direction. Price flexibility is particularly important for fresh apples due to the wide variation in volume of movement among the 12 months of the season and the consequent, large differences in relative changes in price and quantity among those months.

Two aspects of price flexibility are presented--current values and trends. The test for homogeneity of "b" values showed that except for 1967/68, slopes of the regressions did not differ statistically from the base season 1963/64. The large shift in elevation of the 1969/70 regression probably did not represent a shift in demand but rather the measurement of a different (lower quality) commodity. Therefore, in analyzing price flexibility, data for 1967/68 and 1969/-70 were excluded. For the remaining five seasons, slopes of the regression could be considered parallel and the analysis was thus confined to differences due to elevations of the regressions and location on the regressions. The model used permitted season-to-season shifts in the level of each regression but not in the slope. Zero-one shift variables were used, where

$$P_{mt} = a + b_1 X_{1mt} + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5$$

P_{mt} = deflated retail price per pound for apples in month m and season t

X_{1mt} = net movement of fresh apples in month m and season t

X_2-X_5--zero-one shift variables for season in which 1964/65 = X_2, 1965/66 = X_3, 1966/67 = X_4, 1968/69 = X_5.

Results for the five seasons were as follows:

$$P_{mt} = 0.20359 - 0.03087 X_{1mt} + 0.00058 X_2 + 0.00302 X_3 + 0.00882 X_4 + 0.02971 X_5$$
$$(22.04)^{**} \qquad (0.19) \qquad (0.98) \qquad (2.86)^{**} \qquad (9.66)^{**}$$

$R^2 = 0.923$ $\qquad F = 130.16$ $\qquad S.E. = 0.00754$

Asterisks indicate significance at the .01 level.

Quantity and seasonal shift variables in the model accounted for 92 percent of the price variation during the five seasons. As would be expected from results in the preceding section, the shift variables for 1964/65 and 1965/66 were not significant. In other words, the levels of these regressions did not significantly differ from 1963/64. However, the variables for 1966/67 and 1968/69 were significant at the 0.01 level. That is, the levels of these regressions did differ significantly from 1963/64 and the respective regression coefficients measured the difference. Adding these coefficients to the "a" value determines seasonal regressions. Since the first three seasons were essentially the same in elevation, the second and third were eliminated and the period was represented by 1963/64, 1966/67, and 1968/69. The regression for each season was:

1963/64:

$$P_{mt} = 0.20359 - 0.03087\ X_{mt}$$

1966/67:

$$P_{mt} = 0.21241 - 0.03087\ X_{mt}$$

1968/69:

$$P_{mt} = 0.23330 - 0.03087\ X_{mt}$$

For convenience and simplification, price flexibilities were calculated at four points on each regression. The same points were used in each season and represented the average net movement for each 3-month period during 1963/64-1968/69.

Period	Months included	Average pounds per capita per month 1/
I	Sept. - Nov.	2.052
II	Dec. - Feb.	1.758
III	Mar. - May	1.266
IV	June - Aug.	.312

1/ These calculations were made before data for the 7th season were available. Its addition changed the averages as follows: I--1.973, II--1.816, III--1.312, IV--0.330.

Effects on price flexibilities of declining quality over the season and relative changes in prices of substitutes could not be adjusted for or estimated. However, the effects were probably small.

Price flexibilities were all negative and less than one, indicating that a ent change in net movement was accompanied by a less than 1-percent change

in price in the opposite direction (table 6). In each season, the largest response in price to a change in movement occurred in period I (September-November), during which the largest average movement took place. Price responses were next largest in period II, followed by III and IV.

In period I (September-November) of 1963/64, a 1-percent change in net movement was associated with a 0.45-percent change in price in the opposite direction. This price response was the largest encountered in any period or season. In the second period (December-February), the price response to a 1-percent change in quantity was 0.36 percent, compared with 0.24 percent in period III (March-May) and 0.05 percent in period IV (June-August). Because seasonal marketing patterns are quite stable for apples, these points on the regression can also be related to net monthly movements. Price flexibility decreased as net monthly movement became smaller. For the next two seasons, 1964/65 and 1965/66, no appreciable shift in demand occurred; thus, price flexibilities remained essentially unchanged.

By 1966/67, however, the seasonal linear regression indicated a significant upward shift in demand, amounting to a nearly 1-cent increase in price (deflated) at all quantities. In other words, compared with 1963/64, consumers took a given quantity of apples at a price that was nearly a cent per pound higher. This shift made price flexibilities at each point smaller; that is, the percentage change in price in response to a given percentage change in net movement was reduced, although minimally.

By 1968/69, demand as represented by the seasonal linear regression had again shifted upward. Compared with 1963/64, consumers took a given quantity of apples at a price (deflated) nearly 3 cents a pound higher. This sizable shift reduced the price flexibilities substantially. In 1968/69, a 1-percent change in net movement in period I (September-November) was accompanied by a 0.37-percent change in price, compared with 0.45 percent in 1963/64. Price flexibilities in the other periods of 1968/69 were also smaller than in 1963/64.

Table 6.--Price flexibilities for fresh apples, by period for selected seasons, 1963/64-1968/69

Season	Period			
	I-- Average consumption-- 2.052 lbs.	II-- Average consumption-- 1.758 lbs.	III-- Average consumption-- 1.266 lbs.	IV-- Average consumption-- 0.312 lbs.
1963/64	-0.4512	-0.3634	-0.2376	-0.0497
1966/67	-.4249	-.3432	-.2255	-.0475
1968/69	-.3727	-.3031	-.2012	-.0431

Thus, from 1963/64-1968/69, price response to changes in net movement declined. As a result, the impact of changes in net movement on total revenue trended upward. Therefore, although a larger net movement would have increased total revenue in all periods of all seasons studied, the effect on total revenue became progressively greater from 1963/64 through 1968/69. These data suggest that the trade at wholesale and retail levels would favor increased supplies of fresh apples. However, the supply of fresh apples is essentially the growers' decision, involving a derived rather than retail demand; thus, a different conclusion may result.

Total revenue could also be raised by reallocating supplies from periods of higher price flexibility to periods of lower price flexibility--that is, from periods I and II to periods III and IV--if prices in the latter periods are equal to or greater than those in the earlier periods. Allocation of supplies over the season is likewise the growers' decision; and their view of optimum allocation will probably not be optimum from the retailers' standpoint. Therefore, calculations to determine maximum revenue that are based on these retail price flexibilities would be fruitless. However, the trend towards extending the season and increasing controlled atmosphere storage, though based primarily on growers' decisions, benefits retailers also.

DATA LIMITATIONS

The most serious shortcoming in data was the exclusion of Delicious varieties from the sample used by BLS to estimate apple prices. For lack of better data, BLS prices were used in this report. However, as Delicious apples comprise an important part of the fresh market, the consequences of their omission need to be considered.

If demand estimated in this report is to represent a composite of all fresh apples, price changes for Delicious apples must approximate such changes for other varieties that are priced. Otherwise, a substitution effect will occur between BLS-priced apples and Delicious apples. The resulting shifts in demand will apply only to the priced apples. To account for and compare price changes in the two groups, it was necessary to estimate U.S. average retail prices for Delicious apples. Available data include:

City	Retail price per pound for--		
	Apples in BLS sample	Eastern Delicious	Western Delicious
Atlanta	x	x	
Chicago	x		x
Los Angeles	x		x
New York	x	x	x
Pittsburgh	x	x	
Seattle	x		x
U.S. (56 cities)	x		

Prices for Eastern Delicious in three cities and Western Delicious in four cities were expanded to obtain a U.S. price. Two adjustments had to be made: (1) the relationship of prices of the two Delicious types in their limited samples to BLS prices in the same cities needed to be determined; and (2) the relationship between BLS prices in the three- and four-city samples and the U.S. (56-city) sample had to be found. The net effect of these two adjustments for Eastern Delicious apples was used to convert the three-city average price for this type to a U.S. average price. Similarly, the four-city Western Delicious price was converted to a U.S. price. Respective seasonal supplies were used to weight these two prices to obtain a U.S. seasonal average price for all Delicious apples. Season-to-season changes in this price were determined and compared with price changes for BLS-priced apples (table 7). Season-to-season price changes in the two groups of apples differed by 0.5 cents or less--four out of six times. The other two changes were 1.2 and 1.3 cents. The changes in the two groups were within 3 percentage points each season, except in 1966/67, when the difference was 5.8 percentage points. The cross elasticity between these two groups of apples was undoubtedly high and demand was therefore quite sensitive to relative differences in price changes. However, the differences were considered small enough so the substitution effect could be ignored.

These steps reduced the task to estimating how much BLS apple prices would have been raised if Delicious types had been included in the BLS sample. According to these estimates, the inclusion would have raised the BLS seasonal average price by amounts ranging from 1.4 cents a pound in 1966/67 to 2.1 cents a pound in 1969/70 (table 8). These values were deflated with the Consumer Price Index to make them comparable with data used in the original regression; deflated values were 1.6 cents in five seasons, 1.7 cents in one season, and 1.2 cents in the other season.

The 1969/70 season was used to show what demand and price flexibilities would have been if Delicious types had been in the BLS sample. The effect was assumed to be the same each month (the slope of the regression did not change). The adjusted price shifted the price-net movement curve upward (fig. 3). Price flexibilities on the new curve were smaller at all volumes of net movement. The extent of these changes is shown at four points along the curve (once for each time period). In each case, adding the Delicious varieties reduced price flexibility (table 9). For example, if a 10-percent change (which is fairly large) were to occur in net movement in period I, the price would have changed 3.7 percent without Delicious apples and 3.3 percent with them.

Because the effect of omitting Delicious types from the pricing sample was apparently moderate and subject to considerable error in measurement, the estimates were not made for other seasons. However, the price effect in 1969/70 was nearly identical to the effect in five other seasons. Thus, the effect on price flexibilities would have been similar to the effect in the five other seasons also. In the 1966/67 season, the price effect was significantly less than in 1969/70 and the change in price flexibilities too would have been reduced.

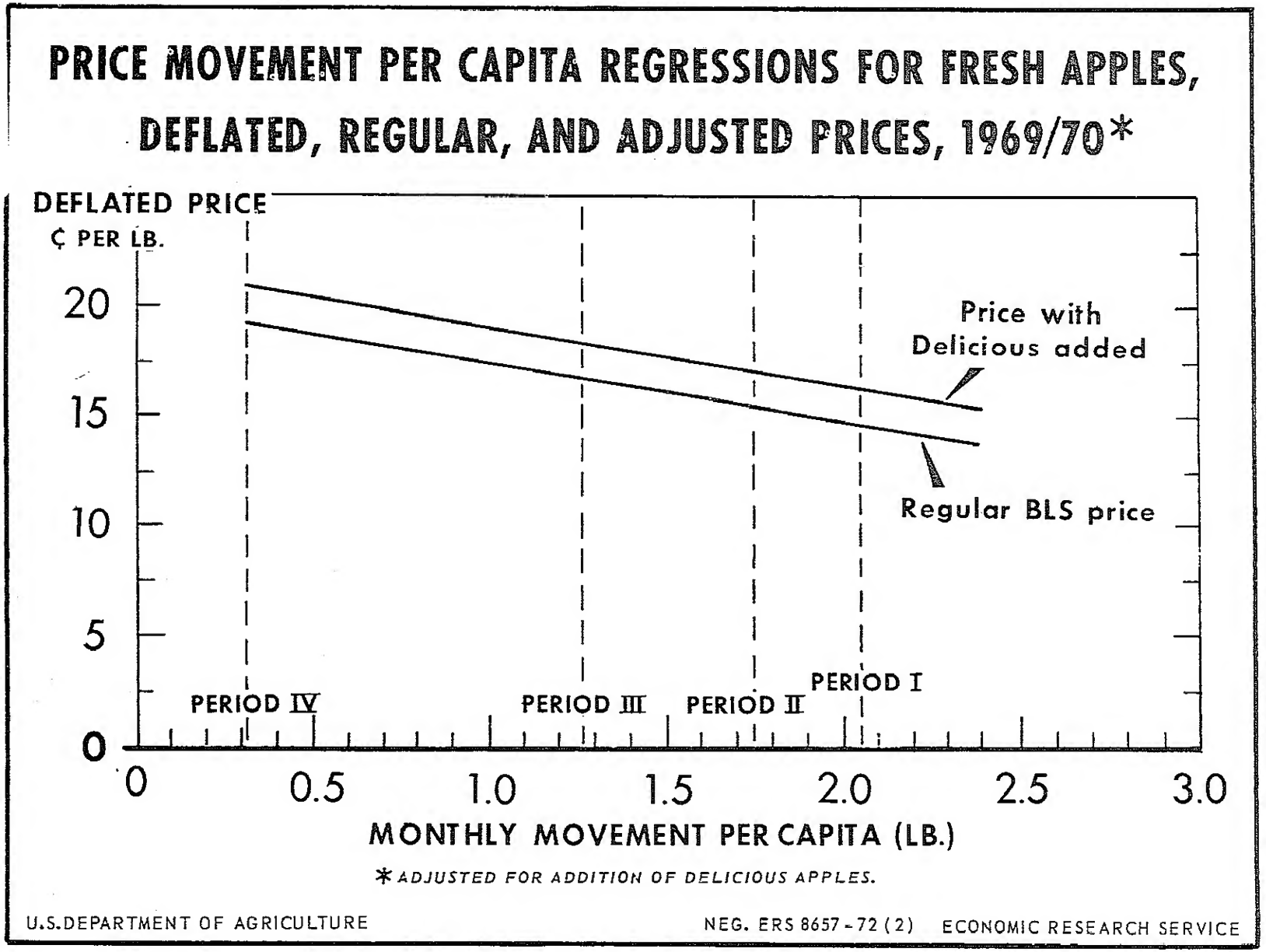
PRICE MOVEMENT PER CAPITA REGRESSIONS FOR FRESH APPLES, DEFLATED, REGULAR, AND ADJUSTED PRICES, 1969/70*
DEFLATED PRICE
¢ PER LB.
20
15
10
5
0
Price with Delicious added
Regular BLS price
PERIOD IV
PERIOD III
PERIOD II
PERIOD I
0
0.5
1.0
1.5
2.0
2.5
3.0
MONTHLY MOVEMENT PER CAPITA (LB.)
*ADJUSTED FOR ADDITION OF DELICIOUS APPLES.
U.S.DEPARTMENT OF AGRICULTURE
NEG. ERS 8657-72 (2) ECONOMIC RESEARCH SERVICE

Figure 3

Table 7.--Season-to-season price changes for BLS-priced apples and Delicious apples, 1963/64-1969/70

Season	Price change from preceding season					
	BLS-priced apples	Delicious apples	Difference	BLS-priced apples	Delicious apples	Difference
	Cents per pound 1/			Percent		
1963/64	-	-	-	-	-	-
1964/65	+1.4	+1.9	0.5	+8.7	+9.5	0.8
1965/66	+2.0	+2.0	0.0	+11.4	+9.1	2.3
1966/67	+0.9	-0.4	1.3	+4.6	-1.2	5.8
1967/68	+3.4	+4.6	1.2	+16.7	+19.6	2.9
1968/69	+0.1	+0.4	0.3	+0.4	+1.4	1.0
1969/70	-2.0	-2.5	0.5	-8.4	-8.8	0.4

1/ Undeflated.

ect on the U.S. average apple price of including Delicious apple prices in BLS sample, by season, 1963/64-1969/70

	Average differential over U.S. price 1/		Proportion of total fresh sales		Estimated effect on U.S. price of including Delicious price	
	Eastern Delicious	Western Delicious	Eastern Delicious 2/	Western Delicious 3/	Current dollars	Deflated dollars
	Cents	Cents	Percent	Percent	Cents	Cents
4	+2.4	+4.2	6	36	+1.7	+1.6
5	-.1	+5.3	7	33	+1.7	+1.6
5/66	+1.1	+5.2	8	33	+1.8	+1.6
5/67	+.3	+3.5	7	39	+1.4	+1.2
57/68	+1.9	+4.9	7	38	+2.0	+1.7
1968/69	+1.6	+5.3	8	34	+1.9	+1.6
1969/70	+2.4	+4.5	8	42	+2.1	+1.6

1/ BLS average U.S. price excluding Delicious.
2/ Includes all but Pacific region Delicious, as published in the International Apple Association mid-November report of storage holdings by varieties.
3/ Includes Pacific region Delicious and all Golden Delicious.

Table 9.--Estimated effect on price flexibilities of adding Delicious apples to BLS sample, by period, 1969/70

Item	Period			
	I	II	III	IV
BLS sample	0.3666	0.2984	0.1983	0.0425
Delicious added	.3307	.2705	.1558	.0393

MONETARY IMPACT OF CHANGES IN DEMAND

The main use of information about demand for a particular commodity relates to revenue from that commodity. Changes in demand can be an important component of changes in revenue but other factors may be significant also. To add perspective and relevance, monetary value was estimated for the changes in demand as well as for three other major contributors to changes in total revenue--population growth, variations in total seasonal fresh movement, and inflation. These four account for a large portion of total season-to-season changes in revenue from the fresh apple crop, which were also estimated.

Total seasonal revenue at retail was found by multiplying net fresh movement data and BLS retail prices adjusted to include Delicious varieties. This estimate was made for each September-August period during 1963/64-1969/70. From these data, season-to-season gains or losses in total revenue were calculated.

The monetary effects of shifts in demand, population growth, changes in total seasonal net movement, and inflation were determined from appropriate net fresh movement data and prices estimated from regression equations developed for this report. Because of statistical error in the estimating procedure and omission of other variables that contribute to changes in revenue, the sums of these four factors only approximate total changes in revenue.

Total revenue from the sale of fresh apples increased each season studied except 1965/66 (table 10). Gains ranged from 5 percent in 1969/70 to 15 percent in 1968/69 and averaged 10 percent. The decline in total revenue in 1965/66 was 7 percent. In dollar amounts (undeflated), the range was from a decline of $43,389,100 in 1965/66 to a gain of $104,851,000 in 1968/69.

Inflation persisted throughout 1964/65-1969/70 and contributed increasingly to the retail value of fresh apple sales. In 1964/65, inflation accounted for about $10 million, or 23 percent of the growth in total revenue. By 1969/70, the figure had risen to $48 million which was more than the gain in total revenue. Thus, although total fresh sales increased in current dollars, they declined when measured in constant dollars.

Increasing steadily over the seven seasons, population made up a relatively small but consistent amount--$5-6 million seasonally. However, season-to-season changes in fresh apple movement caused a relatively large and greatly fluctuating monetary impact on total revenue. The value of these changes moved in the same direction as total seasonal movement, indicating price flexibilities of less than one. In two seasons, 1965/66 and 1967/68, total movement declined from the preceding season and the impact on total revenue was negative--$38 million and $26 million, respectively. In the other seasons, increases in total movement contributed to gains in total revenue by amounts ranging from $12 million in 1964/65 to $66 million in 1969/70.

Demand shifts in the first three seasons studied were relatively small and not statistically significant. In 1964/65, the value of the increase in demand over 1963/64 was estimated at about $10 million. The following season, a decrease in demand accounted for $6 million of the decline of $43 million in total

-Season-to-season changes in retail value of fresh apples and amounts contributed to change by four major factors, 1964/65-1969/70

Factor	1964/65	1965/66	1966/67	1967/68	1968/69	1969/70
	Dollars					
ı or loss in retail value ı preceding season 1/	+45,703,800	-43,389,100	+55,631,300	+66,757,300	+104,851,000	+42,227,600
nt contributed by--						
ıift in consumer demand 2/	+9,612,195	-6,118,779	+25,092,134	+47,684,674	+32,532,705	-84,928,526
Population growth 2/	+6,555,595	+5,768,382	+4,695,859	+5,240,828	+5,298,101	+6,423,701
Change in seasonal fresh movement 2/	+11,863,535	-38,498,327	+17,369,354	-26,223,731	+18,189,332	+65,782,294
Inflation 1/	+10,410,800	+7,938,300	+23,250,700	+27,972,300	+47,582,400	+48,261,500

1/ Current dollars.
2/ Constant dollars.

revenue. However, in the next three seasons, demand shifted upward and contributed substantially to total revenue increases--about $25 million in 1966/67, $48 million in 1967/68, and $33 million in 1968/69. The monetary impact of the apparent decline in demand that occurred in 1969/70 was a revenue loss of nearly $85 million. But this loss was more than offset by gains due to other factors, particularly total fresh movement and inflation. As has been previously explained, this $85-million loss probably resulted more from the generally lower quality of the crop than from an actual decrease in demand. Put another way, the increases in demand in these seasons, with population, fresh movement, and the price index unchanged, raised total revenue 4.3 percent in 1966/67, 7.4 percent in 1967/68, and 4.6 percent in 1968/69.

APPENDIX: CALCULATIONS USED IN STUDY

I.--Procedure for calculating monthly quantity of fresh apples (net movement).

For the study, the most desirable quantity data statistic would have been a consumption figure to go with each monthly price. Although such a statistic is not available, a reasonable substitute was found in monthly net movement to the fresh market. The figures were calculated as follows:

A.--For December, January, and February (period II) and March, April, and May (period III)--

1.--Apparent fresh movement ..... _____
(from International Apple Association Reports)

2.--Less exports ..... _____
(from Foreign Agricultural Service (FAS), USDA)

3.--Plus imports ..... _____
(from FAS)

4.--Gives monthly net fresh movement ..... _____

B.--For June, July, and August (period IV)--

1.--Determine total monthly carlot unloads of summer apples in 41 cities by adding unloads from the following States, as indicated. Convert carlots to pounds by multiplying by 37,720 (820 boxes times 46 pounds) (from Consumer and Marketing Service, USDA).

Alabama
Arkansas
California (July and August)
Colorado
Connecticut
Delaware
Georgia
Idaho
Illinois
Indiana
Iowa
Kansas
Kentucky
Maryland
Massachusetts (July and August)
Michigan (½ of July and all of August)
Minnesota
Missouri
New Hampshire (July and August)
New Jersey (July and August)
New Mexico
New York (½ of July and all of August)
North Carolina
Ohio
Oklahoma
Oregon (July and August)
Pennsylvania (July and August)
Rhode Island (July and August)
South Carolina
Tennessee
Texas
Utah
Vermont (August)
Virginia (July and August)
West Virginia
Wisconsin

2.--Determine movement out of cold storage as follows: (from Summary of Regional Cold Storage Holdings, Statistical Reporting Service (SRS), USDA)

a.--End of May holdings less end of June holdings equals June movement ..... _____

b.--End of June holdings less end of July holdings equals July movement ..... _____

c.--End of July holdings equals August movement ..... _____

3.--For each month, take quantities from steps B-1 and B-2 above and adjust with exports and imports as follows:

a.--Direct movement of summer apples (B-1) ..... _____

b.--Plus storage movement (B-2) ..... _____

c.--Less exports ..... _____
(from FAS)

d.--Plus imports ..... _____
(from FAS)

e.--Gives monthly net fresh movement ..... _____

C.--For September, October, and November (period I)--

1.--Determine fresh movement for period I (September-November) as follows:

a.--Total fresh sales, U.S. commercial apple crop ..... _____
(from SRS)

b.--Less monthly net fresh movement for December-May ... _____

c.--Less movement from storage in June-August ..... _____

d.--Less summer production for June-August for preceding season ..... _____

e.--Gives fresh movement for period I ..... _____

2.--Determine unloads in 41 cities for September, October, and November and calculate the percentage distribution for each month--

September ..... _____
October ..... _____
November ..... _____

3.--Allocate total fresh movements for period I from step C-1-e above to months in same proportion as calculated in step C-2 above--

September ..... _____
October ..... _____
November ..... _____

4.--For September, October, and November (period I)--

a.--Fresh movement from step C-3 above ..... _____

b.--Less exports ..... _____
(from FAS)

c.--Plus imports ..... _____
(from FAS)

d.--Gives monthly net fresh movement ..... _____

D.--Divide each total for monthly net fresh movement as calculated in step A-C above by respective monthly total resident population (U.S. Department of Commerce) to get monthly net per capita fresh movement.

II.--Procedure for adjusting net fresh movement data for September:

Fresh movement data for September were not representative of the time of month during which prices were collected; that is, Tuesday, Wednesday, and Thursday of usually the first full week. Because the rate of movement accelerated rapidly throughout the month, the movement during the first week (when prices are collected) was always considerably below the average for the month. Since nothing could be done about the time of pricing, fresh movement for September was adjusted as though the rate of the first week prevailed throughout the month.

For other months of the season, the rate of movement remained generally quite uniform throughout the month and no adjustments were necessary.

A.--Determine carlot unloads in 41 cities during week in September that BLS collected retail prices.

BLS pricing date	Tues.	Wed.	Thurs.	Carlots for week of--
Sept. 1963	10	11	12	Sept. 8-14
Sept. 1964	1	2	3	Aug. 30-Sept. 5
Sept. 1965	7	8	9	Sept. 5-11
Sept. 1966	6	7	8	Sept. 4-10
Sept. 1967	5	6	7	Sept. 3-9
Sept. 1968	3	4	5	Sept. 1-7
Sept. 1969	2	3	4	Aug. 31-Sept. 4

B.--Determine carlot unloads in 41 cities for September.

C.--Carlots in pricing week divided by carlots in September equals percentage of monthly carlots in pricing week.

D.--Percentage in pricing week times September net fresh movement as previously calculated equals adjusted movement for pricing week.

E.--Adjusted movement for pricing week times 4.2857 equals adjusted September movement.

F.--Adjusted September movement divided by total U.S. resident population on September 1 equals adjusted movement per capita:

Year	Adjusted September movement	Adjusted per capita movement
	------Million pounds--------	---------Pounds----------
1963	292.0	1.543
1964	219.3	1.142
1965	211.1	1.087
1966	209.1	1.065
1967	199.3	1.005
1968	257.3	1.284
1969	181.4	.899

ppendix table 1.--U.S. average retail price for fresh apples, undeflated, monthly and by season, 1963/64-1969/70 1/

Month	1963/64	1964/65	1965/66	1966/67	1967/68	1968/69	1969/70
	Cents per pound						
September	16.8	18.4	17.9	21.2	22.5	24.6	25.7
October	14.2	14.7	15.4	17.3	18.4	20.7	19.4
November	14.0	14.2	15.3	16.6	18.4	20.8	18.5
December	14.8	15.4	16.0	17.6	19.2	21.9	19.0
January	15.0	15.8	16.4	18.1	20.3	23.0	19.6
February	15.5	16.5	16.8	18.5	21.2	23.6	19.8
March	16.1	17.1	18.0	19.2	22.2	24.3	20.4
April	16.8	17.9	19.0	19.9	23.3	24.7	20.7
May	17.9	18.9	20.5	20.6	24.9	25.3	21.9
June	20.2	20.2	22.7	21.9	27.0	27.3	24.3
July	22.8	21.4	23.5	23.7	29.2	28.4	26.0
August	21.8	21.1	25.1	25.3	29.9	28.1	26.6

1/ All-purpose apples, U.S. No.1 or U.S. Fancy, medium-sized (excluding cooking and all varieties of Delicious).

Source: U.S. Department of Labor, Bureau of Labor Statistics.

Month	1963/64	1964/65	1965/66	1966/67	1967/68	1968/69	1969/70	Average
	Million pounds							
Total net movement:								
September	318.1	407.1	358.5	335.0	344.8	406.8	336.0	358.0
October	472.9	518.0	401.7	418.6	460.2	511.5	421.0	457.7
November	356.7	390.7	339.1	350.8	400.1	422.3	303.4	366.2
December	440.0	407.4	417.0	393.7	385.5	330.3	475.9	407.1
January	410.2	346.4	332.9	322.7	312.5	317.2	430.2	339.0
February	367.1	326.4	300.5	299.7	285.8	296.1	408.4	326.3
March	358.7	337.5	305.0	286.9	285.4	278.8	386.9	319.9
April	251.5	254.9	236.4	267.4	218.7	245.7	331.6	258.0
May	162.1	205.6	183.8	215.8	177.1	193.5	245.3	197.6
June	76.8	83.6	97.4	134.0	79.7	99.0	151.9	103.2
July	34.0	45.4	13.0	31.3	41.7	47.7	57.2	38.6
August	54.5	68.1	43.6	60.8	42.0	51.1	58.4	54.1
Total	3302.6	3391.1	3028.9	3116.7	3033.5	3200.0	3606.2	3239.9
	Pounds							
Per capita net movement:								
September	1.681	2.121	1.846	1.706	1.739	2.032	1.667	1.827
October	2.496	2.696	2.066	2.130	2.318	2.552	2.084	2.334
November	1.880	2.031	1.742	1.784	2.014	2.105	1.500	1.865
December	2.316	2.115	2.140	2.001	1.939	1.645	2.351	2.072
January	2.157	1.797	1.707	1.638	1.570	1.578	2.123	1.796
February	1.929	1.692	1.540	1.521	1.435	1.472	2.014	1.658
March	1.883	1.748	1.562	1.455	1.432	1.385	1.935	1.628
April	1.319	1.319	1.210	1.355	1.097	1.220	1.632	1.307
May	.849	1.063	.940	1.098	.888	.960	1.206	1.001
June	.402	.432	.498	.678	.399	.491	.746	.521
July	.178	.234	.066	.158	.209	.236	.281	.194
August	.284	.351	.222	.307	.210	.253	.286	.273
Total	17.374	17.599	15.539	15.831	15.250	15.929	17.825	16.478

BIBLIOGRAPHY

1. Ben-David, Shaul and Tomek, W. G. Storing and Marketing New York State Apples, Based on Intraseasonal Demand Relationships. Cornell Univ., Ag Expt. Sta. Bul. 1007, 1965.

2. Foote, R. J. Analytical Tools for Studying Demand and Price Structures. U.S. Dept. Agr., Hdbk. No. 146, U.S. Govt. Print. Off., Wash., D.C., 19

3. Fox, Karl A. The Analysis of Demand for Farm Products. U.S. Dept. Agr., Tech. Bul. No. 1081, U.S. Govt. Print. Off., Wash., D.C., 1953.

4. Maffett, et. al. Economic Benefits of Optimum Intraseasonal Allocation o New England-New York McIntosh Apples. Univ. Conn. AES Bul. 394, 1966.

5. Mathia, G. A. and Pasour, E. C. An Analysis of Apple Marketing and Stora North Carolina Market Area. N.C. State Univ. Econ. Resear. Rpt. No. 6, 1968.

6. Pasour, E. C. and Gustafon, R. L. Intraseasonal Supply and Demand Functi for Apples. Mich. State Univ. Resear. Bul. 10, 1966.

7. Snedecor, G. W. Statistical Methods. Iowa State Coll. Press., Ames, Iow fifth edit., 1956.